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THE EXTERNAL FEATURES OF THE LARVA OF *ANOMALA VETULA* WIEDEMANN (COLEOPTERA, SCARABAEIDAE).

By Miss B. Bradford, M.Sc.

(*Zoology Department, Rhodes University College, Grahamstown, South Africa.*)

Anomala vetula Wiedemann has been collected from the coastal area of the Eastern Cape Province, between East London and Port Elizabeth, and as far inland as Grahamstown. Péringuey (1902 : 591–592) has described the imagines, and includes Mossel Bay in the distribution. The biology of *A. vetula* has been described in a previous paper (Bradford, 1948). The larvae feed on grass roots and are a potential pest of turf. The three larval instars can be distinguished most easily on the proportional increase in size of the head-capsule of succeeding instars.

Head.—Head-capsule (fig. 2).—Width below bases of antennae : First instar larvae 1·5–1·8 mm.—mean 1·65 mm. (17 specimens) ; second instar larvae 2·4–2·8 mm.—mean 2·66 mm. (36 specimers) ; third instar larvae 3·5–5·0 mm.—mean 4·41 mm. (30 specimens). Length posterior margin to fronto-clypeal suture in first instar larvae 0·7–1·1 mm.—mean 0·96 mm. (17 specimens) ; second instar larvae 1·2–1·9 mm.—mean 1·53 mm. (36 specimens); third instar larvae 2·3–3·4 mm.—mean 2·71 mm. (30 specimens).

Antennae (fig. 3).—Third segment produced distally on inner ventral surface, into a conical process, which extends about one third of length of fourth segment and has a small sense field. Fourth segment asymmetrical, with three sense fields. Antennal prominence, scape and fourth segment have no hairs. One to two basiconic sensilla distal to sense field of third segment, but not quite at tip of conical process, and 7–8 at tip of fourth segment.

Clypeus (fig. 2).—Anteclypeus overlapping labrum, membranous and white, without hairs or sense pits. Postclypeus sclerotized.

Mouth parts.—(1) *Labrum and epipharynx* (figs. 2 and 4). Ratio of length to width (20 specimens) of each instar : First instar, 1·43 ; second and third instars, 1 : 1·32. Asymmetrical, apex crenulate, antero-lateral margins with three obtuse dilations.

Labrum rugose. The number of hairs does not vary, and may thus be of systematic importance. Between transverse row of delicate setae at base and median pair of hairs are 15–20 sense pits in first instar larva, 20–25 in second and 26–30 in the third. Anteriorly are 2–3 sense pits, at base obtuse lateral dilations.

Epipharynx bounded posteriorly by the tormae and the crepis. (Terms are those proposed by Böving, 1936 : 176–181.) Clithrum absent, corypha and acroparia united into a large apical region, which bears setae. Three obtuse dilations on either side each bear a large seta. Anterior projection has four spine-like setae, two setae are ventral and towards the inside of these. Epizygum connected with right arm of zygum ; left arm of zygum a small sclerotized area, not connected with epizygum. Along inside of this discontinuous zygum is a row of 6–10 basiconic sensilla. Heli form a single row of 3–5 strong, immovable spines, directed posteriorly. Pedium depressed, longer than broad and asymmetrical, bordered laterally by the curved articulated setae of the chaetoparia. They are further apart and smaller, towards the plegmatia, and more numerous on right than on left of pedium. Distal 2–3 setae of right chaetoparia stronger than rest, but may be distinguished from heli by their basal rings. Setae of the gymnopariae poorly developed. A diagonal fold extends across pedium from distal region of right chaetoparia to inner end of left torma. Laeotorma has a posterior pternotormal process ; anterior branch entire. Dexiotorma simple. Haptolachus extends posteriorly from inner ends of tormae to crepis. Crepis asymmetrical, more heavily chitinized laterally than medially. A transverse row of about fifteen delicate hairs extends towards middle from left end of the crepis. Sclerome nesium externum attached basally along one arm with other arm directed anteriorly. One to three long hairs on the right of the base. Sclerome nesium internum in the median longitudinal line; inner surface bears two sensilla. Two macrosensilla posterior to transverse series of delicate hairs.

(2) *Mandibles* (figs. 5 and 8). Incisor area limited posteriorly by a notch, proximal to which is a small tooth, sharper in left than in right mandible. Incisor region of left mandible concave, longer than the right, which is "S" shaped. Concavity between incisor and molar regions deeper and shorter in left than in right mandible.

Molar structure of right mandible trilobed. Lobes increase in size towards heel, and are directed ventrally. Molar structure of the left mandible bilobed. Anterior lobe large, and overhangs posterior lobe obliquely. This is elongated, concave and has two transverse carinae. Acia is a thin, chitinous, piliferous projection, on dorsal surface. Projecting arm has a number of short closely set hairs. Inner surface of base bears a row of hairs. About fifty long hairs at base of molar structure of both mandibles, which on left mandible spread out in a semi-circle, but form a cluster on right mandible.

On the ventral surface processus accessorius larger on right mandible than on left. At distal end of scrobis one long seta and at base 13–17 setae, with sense pits interspersed. About fifteen setae along ventro-lateral carina. On dorsal surface of both mandibles two large sense pits, one long seta on incisor area, and a longitudinal row of 6–8 setae near anterior molar tooth.

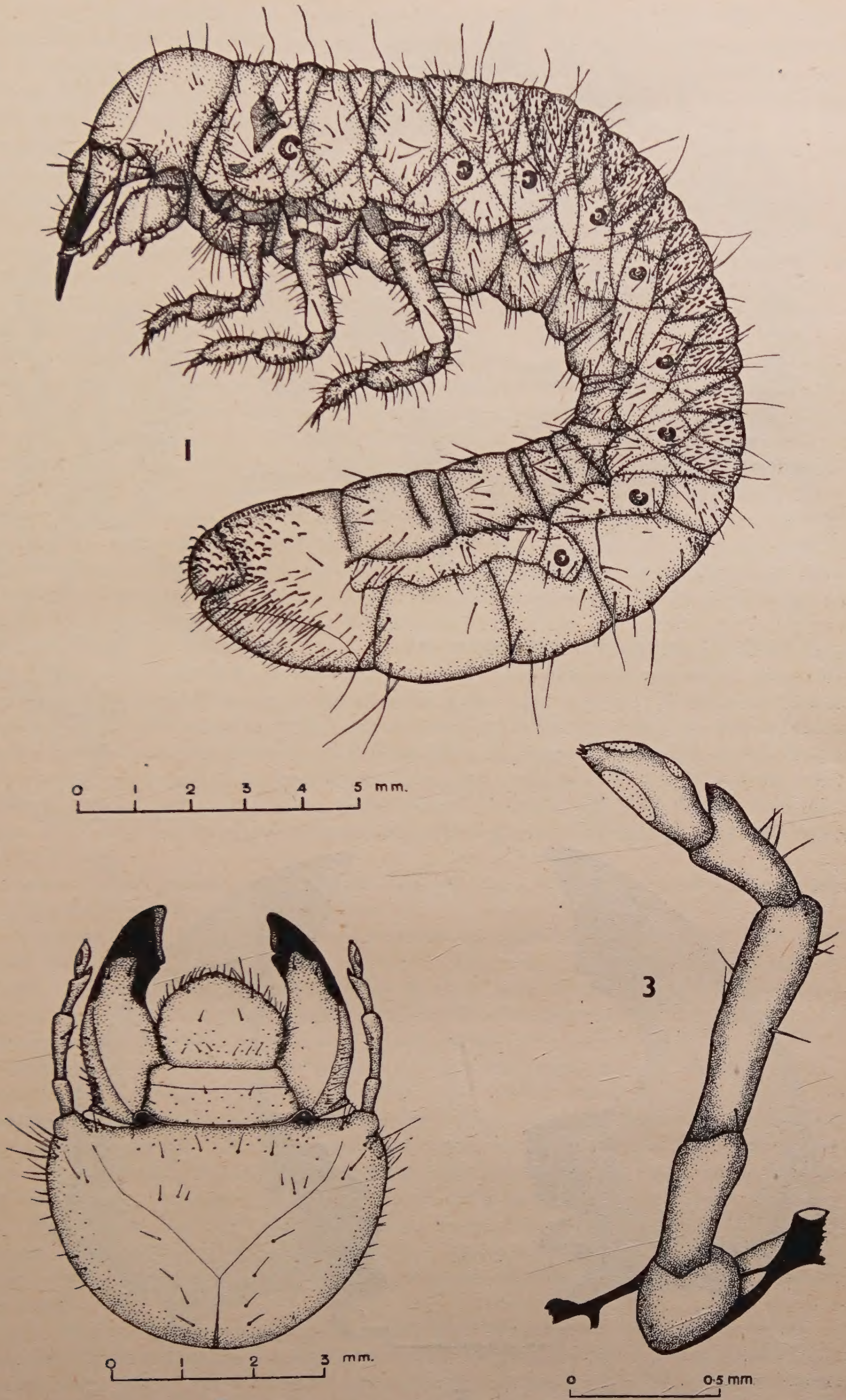
(3) *Maxillae* (figs. 6 and 7). On dorsal surface an "S"-shaped longitudinal sulcus indicates line of fusion of galea and lacinia. Ventral surface of mala formed almost exclusively by galea. Apically galea bears a large immovable galeal tooth, and on outside a half circle of two ventral and three dorsal articulated bristles. Three parallel rows of bristles extend from inner ventral margin of lacinia to apex. Basal row consists of fine hairs. Terminal 3–4 hairs of middle row well developed. Three immovable lacinial teeth at end of top row. Inner tooth often small. Lacinial teeth separated from galeal tooth by a well developed chitinous bar. Rest of lacinia bears fine scattered hairs. A triangular chitinous area at base, with apex directed distally. At base of dorsal surface of galea, a transverse dorso-basal tooth, forming the base of a sclerotized triangle, whose apex is directed posteriorly.

Dorsal surface of both maxillae has 6–8 stridulating teeth. They may differ in number in left and right maxillae. Teeth point forwards, and may overlap one another. Tip of fourth segment of maxillary palp has a circle of ten basiconic sensilla.

(4) *Labium and hypopharynx* (figs. 9 and 10). First prementum is asymmetrical. Labial palps without hairs; tip bears a circle of eight conical sensilla.

Hypopharyngeal sclerome asymmetrical; anterior margin deeply concave; right side forms a strong toothed projection; anterior margin has two small, sharp teeth; left side has a flattened laterally directed process. Area on either side of hypopharyngeal sclerome semi-membranous; it obscures the hypopharyngeal fossae. Right fossa larger than left, to accommodate greater processus accessorius of right mandible. A row of setae on posterior margin of hypopharyngeal sclerome, to right of middle line. On membranous area, to the left of sclerome, a longitudinal row of setae.

Thorax (fig. 1).—In prothorax acrotergite has a dorso-ventral row of hairs. Protergite has a long seta on either side of middle line. Mesotergite has small hairs on the prothoracic sclerite, and ventral to it. Metatergite bears a row of stout hairs. Meso- and metathoracic terga are about same length dorsally. Pro- and metatergites overlap mesotergite. They decrease in size laterally, and extend about half way down body. Mesotergites increase in width to point where the pro- and metatergites terminate, and then narrow to a point dorsal to pleural fold. Acrotergites not visible. Setation of thoracic terga is sparse in contrast to that of abdominal terga. Protergites of meso- and metathorax each



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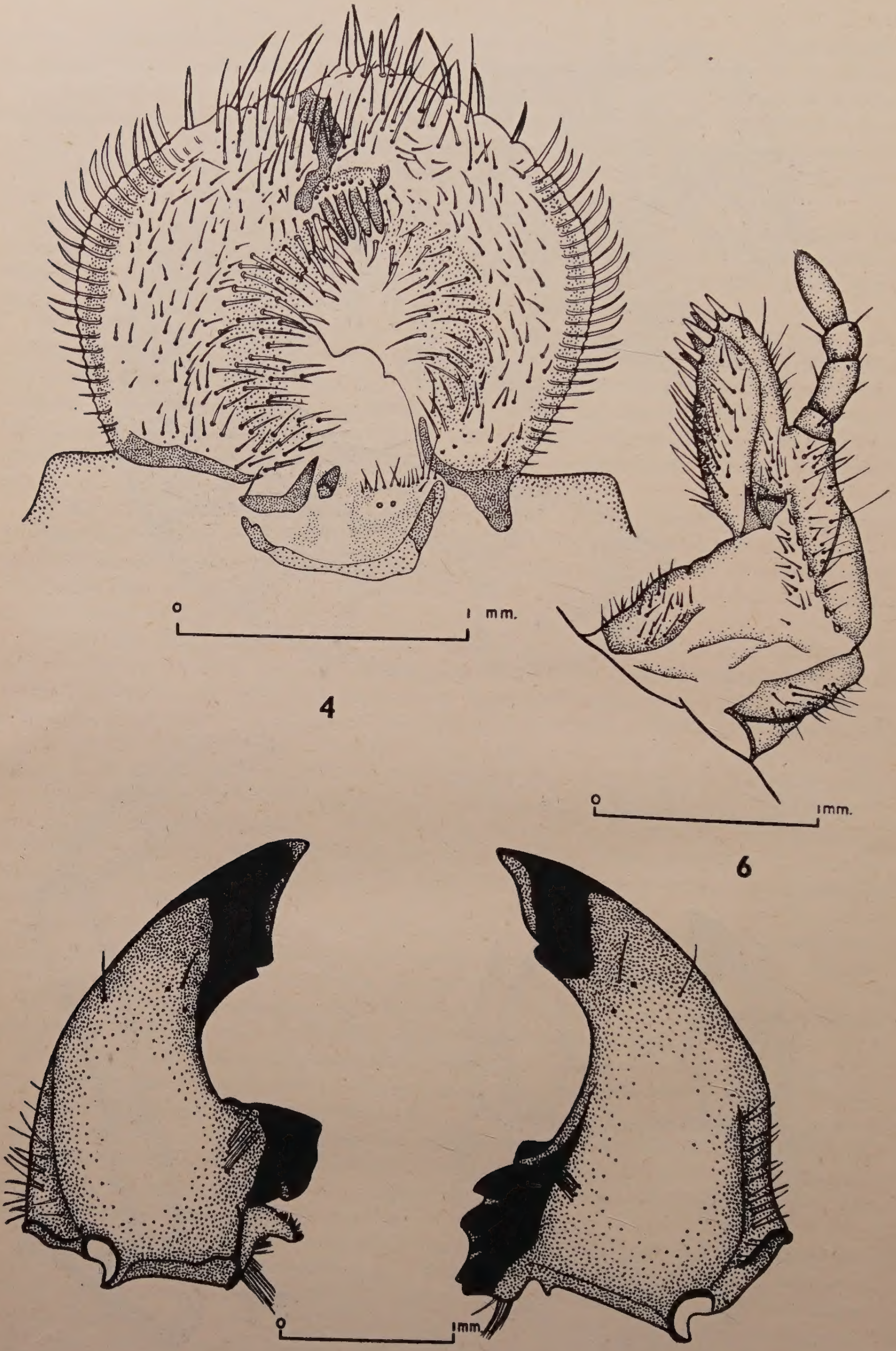
Figs. 1–3.—*Anomala vetula* Wiedemann. (1) Third instar larva; (2) dorsal view of head-capsule of third instar larva; (3) antenna of third instar larva.



FIGS. 4–6.—*Anomala vetula*. (4) Epipharynx of third instar larva; (5) Dorsal view of mandibles of third instar larva; (6) dorsal view of maxilla of third instar larva.

bear a long hair on either side of mid-dorsal line, and a few small hairs. Meso tergites bear a long hair on either side and also scattered hairs. Metatergites have a transverse row of short hairs. A smaller sclerotized plate ventral to prothoracic sclerite is conspicuous in third instar larvae. In first instar larvae a small, sharp hatching spine on either side of dorso-lateral surface of metathoracic mesotergite. Each spine roughly triangular, smooth margined, and situated near posterior margin of a chitinous area. It bears a stiff seta, about twice length of spine.

Pleural region divided into an anterior and a posterior fold in each thoracic segment. Folds bear scattered hairs. Pro- and metasternites are small folds, without hairs. Mesosternite bears a number of hairs directed towards middle line, and especially well developed in the prothorax.

Legs (fig. 1).—Mesothoracic legs intermediate in size between prothoracic and metathoracic, due mainly to increase in size of coxa.

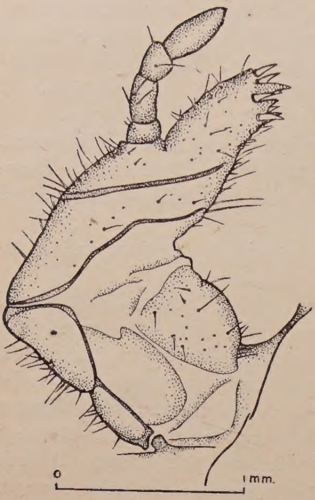
Each leg arises from a subcoxal element. Coxa is longest joint; in second instar larva about twice length of that of first instar larva; ratio in second and third instar larvae less. A triangular membranous area separates coxa and trochanter. Trochanter trapezoidal and at right angles to coxa. Trochanter and femur move as one unit, together about 1·2 times length of coxa. Length of femur doubled from first to second instar; the difference in second and third instar larvae not as great. Coxa 1·4 times length of tibio-tarsus in first pair of legs, 1·8 times in second pair of legs, and 2·1 times in third pair of legs. A circle of strong hairs surrounds base of claw. Anterior to it, three strong hairs arise close together. Metathoracic claw more slender and shorter, than pro- or mesothoracic. Base of each claw bears an inner bristle, which is distal, and extends beyond tip of claw, and an outer which is proximal and does not reach tip of claw.

Abdomen (fig. 1).—Dorsally pro-, meso- and metatergites of segments 1–6 about equal in length. Pro- and metatergites wedge-shaped. Mesotergite trapezoidal. Laterally meso- and metatergites extend to about same level. Acrotergite in front of protergite. Each spiracle on a rectangular field at ventral margin of mesotergite, of first eight segments. A small triangular region posterior to first six pairs of spiracles. A narrow fold is divided from the anterior margin of the metatergite of the first six segments. Terga 7–10 undivided. Dorsal surface of tenth segment has a subcircular field with a chitinized border; it extends almost from anal slit to anterior margin of tenth segment. Posteriorly it is interrupted in middle line.

Pleural region consists of a ventrally directed fold. In segments 7–9 it is elongate; it terminates in anterior region of segment 10.

In segments 1–6 protergite bears a large hair on either side of mid-dorsal line; mesotergite has a long hair on either side, and also a transverse row of short hairs on posterior margin; metatergite has a transverse row of short hairs on posterior margin, except in segment six, where they are scattered. Protergite of first segment has no asperities; the mesotergite has scattered asperities. Metatergite of first segment, tergites of segments 2–5 and pro- and mesotergites of sixth segment densely covered with asperities. Acrotergite bare. Spiracular fold has 6–9 short hairs. Small triangular region posterior to spiracles 1–6 bare. Fold separated from metatergite bears a transverse row of short hairs near posterior margin. Anteriorly segment seven bears short hairs, fewer on segment eight. Posterior half of these two segments bears short scattered hairs, and a few very long wavy hairs. Segment nine has 1–4 short hairs in anterior half; posterior margin has a few short and several very long wavy hairs. Subcircular fold on dorsal surface of tenth segment bears uniformly spaced short hairs. Between subcircular field and anus, and anterior to subcircular field, a few very short hairs. Pleural folds bear 8–10 moderately long hairs.

Mesosternites 1–8 are conspicuous; pro- and metasternites are narrow folds. On either side of mesosternites are small triangular elevations. Ninth segment indistinctly divided into a narrow anterior, and a wider posterior sternite. Tenth sternum undivided. Mesosternites of segments 1–8 and posterior region of the ninth sternum bear hairs. Hairs



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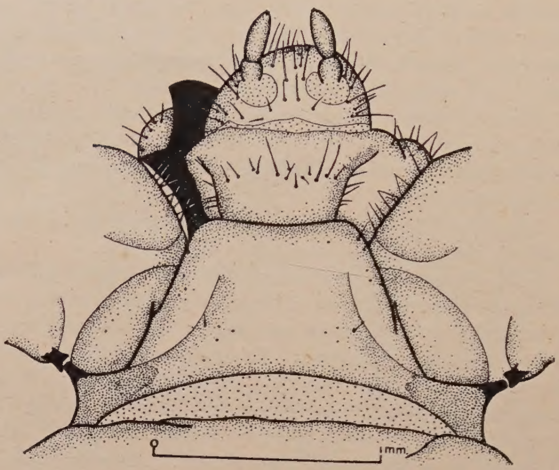

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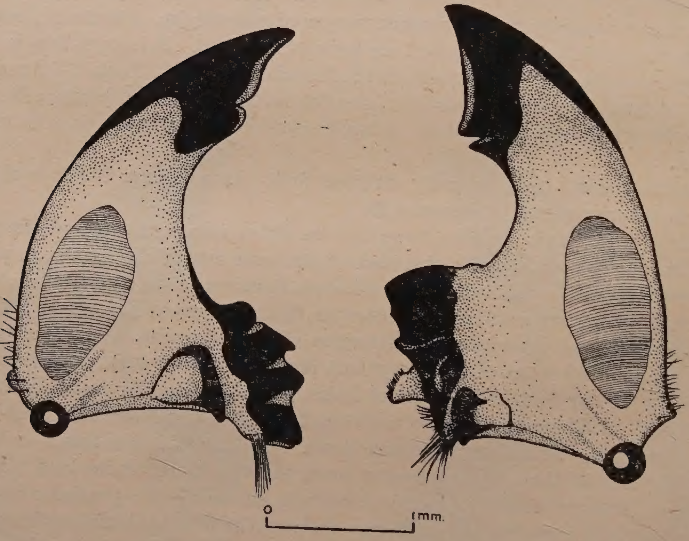

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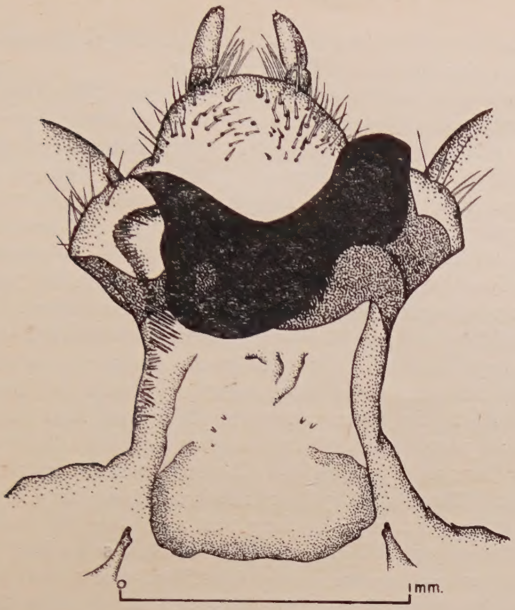
FIGS. 7–9.—*Anomala vetula.* (7) Ventral view of maxilla of third instar larva ; (8) ventral view of mandibles of third instar larva ; (9) ventral view of labium of third instar larva.



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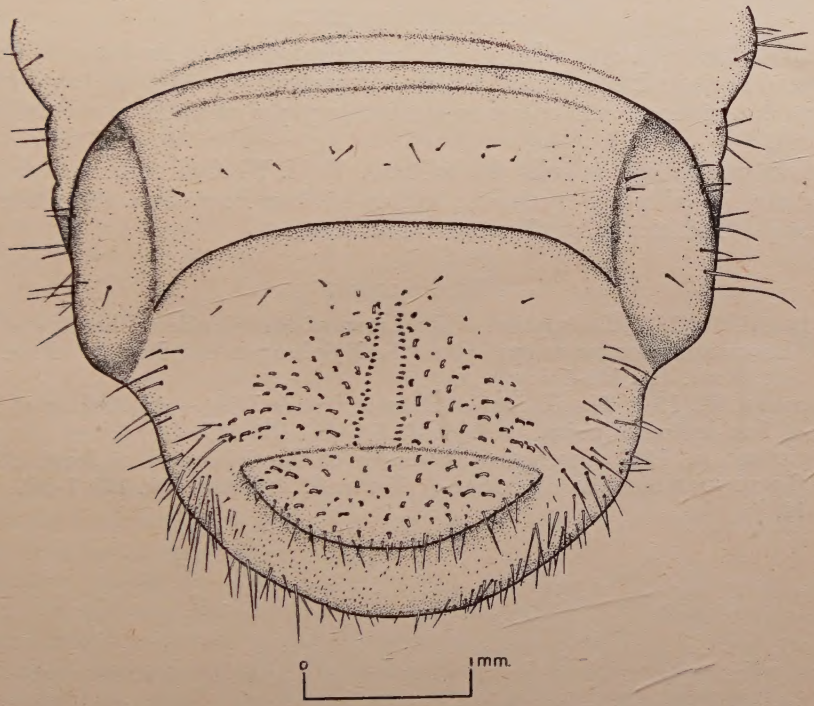

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FIGS. 10–11.—*Anomala vetula.* (10) Dorsal view of labium of third instar larva; (11) raster of second instar larva.

on first abdominal sternum more numerous than on succeeding segments. Lateral triangular elevations of mesosternites bear a few short hairs.

Raster (fig. 11). (Terms used are those proposed by Böving (1936 : 176–181).) Septula is a narrow field between a pair of longitudinal palidia, which diverge posteriorly. Each palidium is monostitious and consists of 16–23 pali. Pali dagger-shaped, about two and a half times longer than broad, separated from one another by a distance about equal to width of their bases. Anteriorly width of the septula nearly as long as two pali, posteriorly nearly as long as five pali. Pali recumbent, with apices directed towards middle line, inserted in basal rings, which are strongly chitinized towards the outside, preventing bending. Each has a triangular inner cavity. Tegillar setae erect and hamate, 25–32 in the first instar, 32–38 in the second instar and 39–43 in the third instar. At the base of lower anal lip they extend from the palidia to corresponding barbula, but anteriorly consist of a few setae adjacent to palidia. They decrease in size anteriorly and laterally. They are irregularly distributed and have small hamate setae interspersed. Tegillar setae flat, each with a long inner cavity. They narrow towards the tip and have strong basal rings, which are strengthened on posterior margin, preventing bending. Campus bare, except for three short hairs on either side of median line. Laterally tenth segment bears long thin hairs, directed posteriorly. The subanal lip bears numerous irregularly arranged hamate setae; hairs on posterior margin moderately long, and arch over the anus.

Spiracles (fig. 1).—Thoracic spiracle larger than abdominal spiracles. Anterior abdominal spiracles oval, long axis being dorsal-ventral; they become rounded in posterior abdominal segments. In first instar larvae sieve plate is reniform and bulla small. Peritreme not well defined and no spiracular slit. In second and third instar larvae sieve plate crescentic, bulla large, and with curved spiracular slit.

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THE SIGNIFICANCE OF THE NUMBER OF WING-HOOKS IN BEES AND WASPS.

By O. W. Richards, M.A., D.Sc.

Alpatov (1929) in a study of variation in the honey bee recorded that in the south of Russia honey bees have longer wings with more hooks (hamuli) on the hind wings than in the north. The hooks serve to hold the pair of wings on one side together during flight and Alpatov suggests that in the south, in dry conditions, bees may have to fly further to get nectar and may, therefore, need more effective wings.

Rayment (1932 : 183 ; 1935 : 512) wrote as follows : " After a close examination of the wings of bees in hundreds of genera and many field experiments on their homing capabilities, I regard the number of wing-hooklets as an infallible guide to the ' air-range ' of the bee. Where the hooklets are four or so, the area of flight is but a few hundred yards ; *Microglossa*, for example, has only three weak ones, whereas the hive-bee, with its twenty-two hooklets, will easily return from a distance of seven miles. My experiments showed that many hundreds of worker-bees returned home, in less than twenty minutes, after being liberated from a point in a dense forest three miles distant. The Australian species of *Trigona* have only from five to six hamuli, or hooklets, and the neuration of the wings is largely obsolete, therefore they are utterly incapable of crossing any moderately extensive natural barrier."

Rayment has not, apparently, published any other experimental data.

Schwarz (1948 : 111–123), after quoting Rayment's observations, makes a detailed examination of the number of hamuli in *Melipona* (10 spp.), *Lestrimelitta* (2 spp.), *Trigona* (74 spp.), *Apis* (1 sp.), *Bombus* (20 spp.) and *Psithyrus* (4 spp.). Queens were only available in 7 species of *Melipona*, 1 of *Lestrimelitta* and 10 of *Trigona*. In *Melipona*, the worker always has more hamuli than the queen and more than the male in two species. In *Lestrimelitta*, the worker has more than the queen. In *Melipona*, the worker has more than the queen in 7 species, but the queen has more than the worker in 3 species of which, however, only one queen was available in each case ; the males always have fewer than the worker. In the honey bee, the queen though larger than the worker has fewer hamuli (means of 16·86 and 20·43, respectively). In *Bombus* and *Psithyrus*, on the other hand, the queen always has more hamuli than the male or worker ; in the first-named genus the number in the male exceeds that in the worker in 11 out of 20 species.

Schwarz points out the contrast between *Bombus*, which has to found her colony unaided, and *Apis* and the Meliponidae, which found colonies by swarming and therefore do not require the queen to engage in foraging. He suggests the number of hamuli might be better correlated with the weight of the insect than with any other measure of size. He also points out that within the Meliponidae the absolute number of hamuli is not correlated with the size of the geographical area inhabited by a species.

Having for some years paid attention to this question in the VESPIDAE and in *Bombus*, and given the hint contained in Rayment's observations, I am able to carry observation and speculation somewhat further.

Dr. R. A. Cumber recently investigated the biology of a number of species of *Bombus* (1949, *Trans. R. ent. Soc. Lond.* **100** : 1–45) and he has kindly allowed me to analyze some of his data, which include measurements of the weights, wing-lengths and hamuli number of 717 ☿ and 148 ♀ obtained from 19 nests of *Bombus agrorum* (Fab.) at Slough, Bucks, during the summer of 1946. This species belongs to the group of the genus in which the size of workers and queens just overlaps.

Summary of Measurements.

☿ Weight (mg.)	26–280, mean 114·30.	♀ Weight (mg.)	208–448, mean 333·94.
Wing-length (mm.)	5·25–13·25, mean 10·12.	Wing-length (mm.)	11·75–14·75, mean 13·68.
Hamuli	13–22, mean 17·84.	Hamuli	18–23, mean 20·13.

In the queens both weight and hamuli number are significantly correlated with wing-length, but the correlation of hamuli with weight is not significant. In the workers all three characters are very significantly correlated with one another, but when the partial correlations are calculated, weight and hamuli number are still very significantly correlated with wing-length, whereas the correlation of weight and hamuli is no longer significant when the effect of wing-length is eliminated. The meaning of this can most clearly be seen when a number of workers of the *same* wing-length is studied ; it is found that there is no regular relation between weight and hamuli number. Thus, of the 717 ☿, 114 had a wing-length of 10·25 mm. ; in these the relation between hamuli number and weight was as follows :

Hamuli number . .	16	17	18	19	20	21
Number of specimens .	9	27	39	23	14	2
Mean weight (mg.) . .	104·6	112·1	112·4	109·2	110·6	100·0

It can be shown by comparing the regression coefficients that the relation between wing-length and weight differs significantly between queens and workers, whereas the relations between hamuli number and wing-length do not. The great range in the magnitude of both wing-length and weight in the worker means that there is a steep increase as one progresses from small to big workers ; in the queens, with their greater uniformity of size, the corresponding increase is much less steep.

In an earlier paper (Richards, 1946) I showed that workers of *B. agrorum* could be separated into " foragers " and " nurse bees." The former are those which carry pollen, many of them returning to the nest-site after the nest has been removed. The nurse bees are defined as all those found inside the nest (i.e., a fraction of the foragers is probably included with the true nurses). It was shown that the foragers are heavier, have longer wings, and possibly have relatively more hamuli than the nurse bees. Dr. Cumber's observations have confirmed these distinctions, except the last. In the 19 nests already referred to, the distinction between the two types of worker was made in 9 nests, providing 444 nurse bees and 195 foragers for comparison.

Caste.	Part measured.	Range.	Mean.	Hamuli per mm. wing-length.	Regression of y on x.
Nurse bees.	Wing-length (x)	5·25–12·75.	9·80 mm.		
,,	Hamuli (y)	13–22.	17·43.	1·779.	$y = 17{\cdot}43 + {\cdot}85\,(x - 9{\cdot}80)$.
Foragers.	Wing-length (x)	6·75–13·25.	11·10 mm.		
,,	Hamuli (y)	15–22.	18·62	1·677.	$y = 18{\cdot}62 + {\cdot}62\,(x - 11{\cdot}10)$.
All workers	.	.	.	1·76.	$y = 17{\cdot}84 + {\cdot}72\,(x - 10{\cdot}12)$.
Queens.	.	.	.	1·47.	$y = 20{\cdot}13 + {\cdot}76\,(x - 13{\cdot}68)$.

All regression coefficients significant ($P < {\cdot}01$).

A comparison of the relation of y to x in nurses and foragers by analysis of co-variance shows that the difference is not significant. It may therefore be concluded that wing-length, weight and hamuli number are significantly related, but that hamuli number is not influenced by weight (except through wing-length). There is no evidence that workers, foragers and queens differ significantly from one another, apart from size. The slopes of the regression lines are, however, such that small specimens of *Bombus agrorum* have more hamuli per millimetre wing-length than large ones. Where bees differ much in size it may be misleading to make a direct comparison between the absolute numbers of hamuli.

In the VESPIDAE an externally discontinuous (or nearly) worker caste occurs only in the VESPINAE; in the POLYBIINAE and POLISTINAE, it is only possible to recognize the workers by observing their behaviour or by dissecting them to find which ones have developed ovaries, and sperm in the spermatheca. A study has been made of 35 queens and 100 workers of *Vespula vulgaris* (L.) (VESPINAE); wing-length (to the nearest half-millimetre) and hamuli number were recorded, with the following results:

Caste.	Wing-length.	Hamuli number.
Queen	13·75–15·25, mean 14·41	25–32, mean 28·29
Worker	9·25–12·75, mean 10·37	18–30, mean 23·51

Regression of hamuli number (y) on wing-length (x) in worker:

$y = 23{\cdot}51 + 1{\cdot}264\,(x - 10{\cdot}37)$. Regression coefficient significant ($P < {\cdot}01$).

In the queens the relation between hamuli number and wing-length is not significant, but in the worker it is. If, in the worker regression equation, the queen mean wing-length, 14·41, is substituted for x, the hamuli number, y, comes out at 28·62, very near the actual queen figure. However, as in *Bombus*, the smaller individuals have more hamuli per millimetre wing-length, as shown below.

Wing-length, ☿.	Hamuli per mm. wing-length.	Number of specimens.
9–10	2·34	38
10–11	2·26	43
11–12	2·14	15
12–13	2·16	4
Queens	1·96	35

In the POLYBIINAE, data are available for a number of species studied by my wife and myself in British Guiana and for *Belonogaster griseus* (Fab.), kindly sent from Natal by Dr. R. F. Ewer and dissected by me in London. In *Polybia bistriata* (Fab.), *Protopolybia pumila* (Sauss.) and *Brachygastra scutellaris* (Fab.) the queen has significantly more hamuli than the worker, usually associated with longer wings. In *Polybia occidentalis* (Oliv.), however, the queen in some nests has fewer hamuli than the worker (though with longer wings) and in all nests has significantly fewer hamuli per millimetre wing-length. In *Belonogaster* the specimens with better developed ovaries had longer wings and more hamuli, but the differences were not significant.

In the POLISTINAE two S. American and one African species have been studied and the queen always had longer wings and more hamuli than the worker, though the numbers of queens were rather small.

The POLYBIINAE discussed above found their new colonies by swarming, so it is interesting in them to find a further example of queens with fewer hamuli than in the corresponding worker. Probably this has not happened more often in the POLYBIINAE because the caste differentiation is very slight and because the queens, though probably not foraging, retain a good deal of mobility, so that in an emergency all the adults can fly to a new nest-site. Tropical *Polistes* often, but not always, found new colonies by swarming. The VESPINAE, as far as is known, never do so.

SUMMARY.

(1) There is some evidence that the number of hamuli is related to the normal flight-range of bees.

(2) In *Bombus*, at any rate, wing-length is related to weight, hamuli number to wing-length but not directly to weight.

(3) Smaller individuals tend to have fewer hamuli than bigger ones, though usually more hamuli per millimetre wing-length.

(4) Queens are usually larger and have more hamuli than workers. But in forms which found new colonies by swarming, so that the queen at no time has to spend much time flying (MELIPONIDAE, *Apis*, at least one species of *Polybia* (VESPIDAE)), the queen may have fewer hamuli although she has longer wings than the worker.

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THE OCCURRENCE AND DIMORPHISM IN BRITAIN OF *METOPEURUM FUSCOVIRIDE* NOM. N. (*PHARALIS TANACETI* AUCTT. NEC. L.) (HEMIPTERA, APHIDIDAE).

By H. L. G. Stroyan, M.A., F.R.E.S.

References in the British literature on Aphids to the occurrence of *Metopeurum fuscoviride* **nom. n.**[1] (= *Pharalis tanaceti* (L. 1758) auctt. nec. L.) are few and far between.

Buckton (1875) mentions apterae taken by Walker in the Isle of Wight, and alatae found by himself on *Lapsana*, locality not given; these latter are doubtfully referable to this species, and were probably some species of *Dactynotus* Rafinesque.

Theobald (1927) knew of no other records, and had never found the species, though Davidson (1925) gives an extensive distribution in Southern England, without, however, giving a full list of references by which this can be checked; his records consist of county names only.

C. Morley (1908) stated that he had taken the species from *Taraxacum* in Suffolk in 1907; but the circumstances of the record leave little doubt that these aphids (unfortunately never mounted except on cards) were *Dactynotus* (*Uromelan*) *taraxaci* (Kaltenbach).

It would therefore appear that only one fully authenticated record has ever been published, Walker's Isle of Wight apterae; though this statement may be subject to correction. Hille Ris Lambers (1939) remarks on the curious absence of records from Britain since Buckton's day; the very local occurrence of Tansy and its lack of economic importance may have something to do with this, for a similar dearth of records is also noticeable for the other Tansy species, *Dactynotus tanaceti* (L. 1758), *Coloradoa tanacetina* (Walker) and *Macrosiphoniella persequens* (Walker).

Thanks to the help of Messrs. F. H. Jacob, H. G. Morgan and J. P. Rogerson, I have before me a number of authenticated records, both positive and negative, which show *Metopeurum fuscoviride* to be a widely distributed insect in Southern and Eastern England, at least up to a line drawn between the Wash and the Bristol Channel. Negative evidence for Northern England and North Wales supports the view of a southern range in Britain, which tends to confirm Davidson's data referred to previously.

The authentic records so far known are:

(1) Devonshire: Rackerhayes, near Newton Abbot, 1944; Clyst St. Mary, 1945 and 1948; Newton Poppleford, 1946; Clyst Honiton, Rockbeare, Fairmile and Starcross (Exeter), 1948 (all records those of *H. G. Morgan*, who adds the statement that the insect is "common in Devon").

(2) Somerset: Banks of the Avon between Saltford and Bath, and in the village of Saltford, 22.vi.47 (*H. G. Morgan*). These colonies were all of a green form, to be described in a later paragraph.

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[1] A full discussion of the grounds for the change of name applied in this paper to the species formerly known as *Pharalis tanaceti* (L.) will appear when the *Transactions* of the 8th International Congress are published.

(3) SURREY : West Byfleet, abundant on *Tanacetum vulgare* f. *crispa*, and found at various dates throughout the summers of 1947 and 1948 (*H. L. G. Stroyan*). These colonies were also of the same green form referred to above, with no admixture of the typical form : sexuales were abundant on 6.xi.47.

(4) CAMBRIDGESHIRE : Cambridge University Botanical Garden, 11.viii.47 ; 1 alata and 2 apterae only, with a few young nymphs (*H. L. G. Stroyan*).

(5) NORFOLK : Stoke Holy Cross, 28.vi.44, apterae and alatae (*F. H. Jacob*).

(6) SUFFOLK : Halesworth, 21.vi.48, abundant on Tansy by the roadside. Easton Bavents, Southwold, 25.vi.48, two or three colonies. Palgrave, 3.vii.48, a few nymphs only from Tansy by the roadside (*H. L. G. Stroyan*).

Negative evidence is as follows : Mr. Jacob (*in litt.*) says, " I have never seen the species in the North or West, but have often searched for it in North Wales." Mr. Rogerson says, " . . . the only Macrosiphini found on *Tanacetum* by me is *Macrosiphoniella tanacetaria* (Kalt.), which is quite common up here " (Northumberland).

The most interesting feature of the records quoted above is the simultaneous recording in Surrey and Somerset of the green colour form of the species ; this form has never previously been described. The apterous males are described by Hille Ris Lambers (1947) as typically green, but all other forms are consistently described in all previous works as reddish brown and blackish. Exceptions are early descriptions by Geoffroy, Fabricius and Kaltenbach (the latter for alatae only) which appear to refer to other species.

In the green form the markings and morphological characters of all the life-forms and all stages of the species are the same as in the typical colour form, and the biology is also exactly similar ; my colour notes read as follows :

Apterous viviparous ♀ : Head, pronotum and mesonotum fuscous ; metanotum and pleural region of abdomen to just before siphunculi pale greenish yellow to greenish white. The whole central area of the abdominal dorsum is occupied by a large, squarish, dark green patch which spreads laterally at the level of the siphunculi to occupy the whole width of the abdomen. Apex of abdomen pale greenish yellow ; ventral surface pale greenish white, very slightly pulverulent. Antennae, legs except bases of femora, siphunculi and subgenital plate blackish ; cauda pale to dusky. Eyes red.

Alate viviparous ♀ : Similar to apterae, but entire thorax and head black and sclerotic ; wing veins brownish, pterostigma greenish grey.

Oviparous ♀ : As for apterous vivipara.

Apterous ♂ : Apparently typical.

DISCUSSION.

(1) The British distribution of *Metopeurum fuscoviride*.

The evidence quoted suggests that the south-western peninsula is the most favoured part of Britain for the species. Davidson (*loc. cit.*) gives Cornwall in his distribution, and Morgan's comments show that in Devon the species is abundant in suitable localities. In the south-east and east the records are more scattered at present, but this may alter as more collecting is done. The old record from the Isle of Wight links the eastern and western distribution areas. At present no records are available for the areas north of a line drawn from Bristol to the Wash ; and in view of the intensive collecting done in

North Wales by Messrs. Jacob, Thomas, Hille Ris Lambers and others during 1938 and 1939 and subsequently, the absence of the species from North Wales may fairly be assumed. The north shore of the Bristol Channel might well be further explored, however; and in view of its wide distribution in north-western Europe (*teste* Hille Ris Lambers (1939)) there seems to be no good reason why *fuscoviride* should not be found further to the north on the east side of Great Britain. Very little can be said with certainty as to what factors other than the presence or absence of its foodplant determine the geographical range of an aphid; but at least it would seem that no other explanation is necessary to account for the paucity of records of *M. fuscoviride* in this country, since nowhere in Britain can such abundance of *Tanacetum* be found as occurs along railway banks and roadsides throughout Holland and Northern Germany.

The fact that all the records of the species quoted are from places within forty miles or so of those parts of the coast which face the continent suggests the possibility that *fuscoviride* maintains itself in this country by periodical influxes of alatae carried over by easterly or southerly winds in years when the species is common on the continent; where these alatae alight successfully on their foodplant, colonies will be founded which can be successfully maintained unless or until adverse factors, climatic or biotic, effect their extinction. One such adverse factor may be high rainfall, for it will be seen that on the whole the localities from which the species has been recorded lie within the driest portion of the country, while it appears to be absent from North Wales and has not been recorded from the North of England or from Scotland.

(2) Colour dimorphism.

It is worthy of note that in the two widely separated localities where the newly described green form occurred it was the only form present; neither has the typical form turned up as yet in separate colonies in proximity to the green form. It would appear, therefore, that this is a different form of dimorphism from that occurring in a number of other genera of the Macrosiphina, such as *Macrosiphum* Passerini, *Aulacorthum* Mordvilko and *Acyrthosiphon* Mordvilko, where the two forms may occur together in mixed colonies.

The fact that the males of *Metopeurum fuscoviride* are typically green suggests a very simple genetic control of colour by a gene situated on the X-chromosome and achieving phenotypic expression only in double dose. Such a mechanism would also apply probably to the species of *Dactynotus* Rafinesque in which green males are the rule. The occurrence of colonies in which all forms are green would be due to a single mutation at this locus. The ease with which casual mutations in aphids may establish themselves by the development of clonal lines would make such a mutation (which would almost certainly be a pure recessive) very much less susceptible to the consequences of adverse selection than would be the case in most other groups.

The actual mechanism of the colour change is apparently the suppression of a red pigment. Buckton (1875) refers to a " fine red colour " imparted to Canada balsam by his *tanaceti*; this would indicate a pigment soluble in xylol or benzol, and it is likely that this is the pigment suppressed. Certainly the superposition of a red pigment on the green and yellow pattern of the mutant form would accurately reproduce the coloration of the typical form.

The selective value or otherwise of the mutation is doubtful. Any additional procryptic value of the green colour is quite offset by the way in which the aphids cluster round the stems and by the ceaseless coming and going of the attendant ants. On the other hand, it is not improbable that the red and brown pigments of many aphids have some aposematic rôle; the conspicuous brown colonies of *Dactynotus* species are strikingly free from molestation by birds, and I have recently found a Capsid nymph, which I was unfortunately unable to rear, which mimicked with great faithfulness not only the colour and build but also the slow movements of the species *Dactynotus cirsii* (L.) among which it lived, and on which it was preying when collected.

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BOOK NOTICE.

A Textbook of Entomology. By HERBERT H. ROSS. New York (John Wiley & Sons, Inc.) and London (Chapman & Hall, Ltd.), 1948. Pp. ix + 532, text illust. Price 36s.

As the author states in his preface, this book has been written to meet the need for an introductory textbook covering the fundamental aspects of entomology, organized so as to give students a general idea of the entire field. The subject has been dealt with in ten chapters, as follows: (1) Growth of North American Entomology; (2) Arthropoda: Insects and their Allies; (3) External Anatomy; (4) Internal Anatomy; (5) Physiology; (6) The Life Cycle; (7) The Orders of Insects; (8) Geological History of Insects; (9) Ecological Considerations; (10) Control Considerations.

At the end of each chapter a short list of references is given, and there is an index of 16 pages.

A PRELIMINARY ANALYSIS OF OVIPOSITION BEHAVIOUR BY *LOCUSTA* (ORTHOPTERA, ACRIDIDAE) IN RELATION TO MOISTURE.

By John S. Kennedy, M.Sc., Ph.D., F.R.E.S.

(*From the Zoology Department, University of Birmingham.*[1])

Introduction.

Field observers of locusts have reported that oviposition occurs only after a fair amount of rain has fallen (Johnston, 1924, on *Anacridium moestum melanorhodon* Walker; Cotterell, 1931, on *Locusta migratoria migratorioides* Reiche and Fairmaire; Ramachandra Rao, 1934, and Maxwell-Darling, 1934 and 1936, on *Schistocerca gregaria* Forskål). Hamilton's (1936) work suggested that sexual maturation, which is, of course, a necessary preliminary to oviposition, requires a moderately high humidity. But as yet no clear experimental distinction has been made between the direct effects of air humidity and the effects of food-plant condition. Maxwell-Darling (1934) considered that, while the sexual maturation of *Schistocerca* is brought about by a mere rise in relative humidity, actual oviposition requires rainfall which moistens the sand. He observed two females of *Schistocerca* digging in dry sand but not laying until the sand was moistened by rain. Johnston and Maxwell-Darling (1931) described *Locusta* as digging repeatedly in dry sand, the top few millimetres of which were moist, but the locusts finally laid on the floor of the cage. When rain moistened the sand more deeply, laying took place in the sand. Faure (1932) also found in cage experiments on *Locusta* that egg-laying occurred in wet sand and not in dry. The general conclusion is that while a fairly high humidity is enough to bring about maturation and even the initiation of the oviposition process, the completion of egg-laying proper requires either the texture or the humidity of moist sand.

The present work was concerned with the effects of air and soil moisture upon the process of oviposition in its various stages, using locusts already in a condition of readiness to lay. It was carried out some years ago in the Zoology Department, University of Birmingham, with the aid of a grant from the Anti-Locust Research Centre. The work could not be taken far, but it has been decided to publish it in the hope that there may be others who are able to extend it.

Normal Egg-laying.

The process of oviposition has been described by Fedorov (1927) for *Anacridium aegyptium* (L.), and may be briefly recapitulated here, supplemented from my own laboratory observations on *Locusta migratoria migratorioides* R. and F., *phasis transiens*. Fedorov says that a female which is about to oviposit comes down from its normal position on the walls or twigs in the cage on to the ground and that there the ovipositor begins to make movements, as if attempting to dig. I have often observed females opening and closing the large valves of the ovipositor with the abdomen unbent and unextended, but such movements were evidently not a prelude to oviposition in any immediate sense, since they could be observed intermittently for hours without any sign of probing, i.e. arching of the abdomen and working of the valves into the floor. Probing of the hard floor was seen only rarely and might always have been preceded by probing in sand; this point was not settled. The early steps in digging were found to be somewhat variable, so that the following must be taken as a generalized account.

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The locust is seen to be feeling the surface, upon which she is walking, with her antennae and palps. When she moves on to a moist sand surface the abdomen bends down slightly and taps the surface of the sand gently with the valves of the ovipositor closed. The abdomen is then fully arched and the ovipositor begins to enter the sand almost at right angles. The process of digging by means of opening and closing the valves and thrusting downwards is continued until a hole several times the normal length of the abdomen has been made and the inside of the hole enlarged and smoothed by twisting movements of the tip of the abdomen. The protrusion and retraction movements of the head which accompany this process are considered by Fedorov to assist in passing air into the gut and so extending the abdomen in conjunction with the enlargement of the air sacs. The abdominal musculature, he maintains, plays no part in thrusting, but executes the interpolated twisting movements. When digging has been completed there is a short pause after which a frothy secretion is poured out into the bottom of the hole and the eggs are passed out and embedded in the froth. The abdomen is slowly withdrawn, leaving behind a column of froth and eggs, up to about an inch from the surface, when no more eggs are extruded, and the hole is filled up to the surface with froth alone. By this time the locust is again raised up on its legs and the abdomen returned to its normal shape and position. A lengthy process of scuffling and trampling of the sand in the region of the top of the egg pod just laid is carried on by the hind legs, and the locust finally moves off, usually to feed. The whole process from the initiation of digging to the completion of trampling lasts about two hours.

EFFECT OF SOIL CONDITIONS ON THE SUCCESSIVE STAGES OF OVIPOSITION.

The soil used in all these experiments was clean " silver " sand, contained in tubes (4 in. long by 1¼ in. diam.) the tops of which were flush with a perforated zinc false floor. Under this false floor was a carpet of moist sand which served to maintain the relative humidity in the cage between 50 and 80 per cent., and also, perhaps, provided upward convection currents of moist air. This arrangement reproduced the conditions existing on bare patches of ground after rain, except for the texture of the surface of the perforated zinc.

The first experiment was a comparison of digging and oviposition in tubes filled with moist sand, and in tubes containing moist sand covered by 2–3 cm. of dry sand. Tubes of these two types were provided in equal numbers, and spaced so as to make it impossible for a locust to dig in one tube while in contact with another. The positions of the two types of tube were alternated daily. Holes made in loose dry sand immediately fill up again when the abdomen is removed. In order to obtain records of diggings which penetrated only the dry upper layer of the one set of tubes, the dry layer was made up of sand of two distinctive colours, one above the other. The lower of these two dry layers became, after 24 hours, just sufficiently moistened from the wet sand below to pack very slightly. The upper dry layer could then be tipped off, with gentle tapping, and places where diggings had taken place could be detected as a column of sand of contrasting colour passing through the lower dry layer.

Table I shows that the total number of diggings started in the two sand conditions was the same, but twice as many diggings were completed in the all-moist sand as in the dry-topped sand. Half the holes started in dry-topped sand did not reach down into the moist sand below, whereas all the holes started in all-moist sand were completed. None of the short diggings in dry sand contained eggs or froth. Among the full-length diggings egg-pods were laid in about 70 per cent. of those in all-moist sand, but in only 50 per cent. of those in dry-topped sand.

TABLE I.

	Moist sand.	Dry covered moist sand.	Totals.
Empty holes not reaching into moist sand	—	29	29
Full-length empty holes	17	14	31
Egg pods	39	15	54
Total full-length diggings	56	29	85
Total diggings	56	58	114

TABLE II.

	Sodden sand.	Moist sand.	Dry sand.	Totals.
Empty holes	32	12	?	44
Good pods	11	47	0	58
Imperfect pods . . .	12	1	0	13
Total pods	23	48	0	71
Total diggings . .	55	60	?	115

In the second experiment, tubes filled with sand in three conditions—dry, moist and sodden—were offered. No attempt was made to record diggings in the dry sand. Empty holes in the sodden sand tended to lose their shape and partially fill up, so that full-length diggings could not be distinguished from holes abandoned half-dug by the females. Among the egg-pods, however, badly misshapen ones, with less than a normal complement of eggs, were recorded separately from more or less perfect ones. Table II shows that nearly as many diggings were made in sodden as in moist sand. Among the holes dug, eggs were laid in 80 per cent. of those in moist sand but in only about 40 per cent. of those in sodden sand. Among the pods laid, all but one were perfect in moist sand, but half were misshapen and incomplete in sodden sand. No egg-pods were laid in the dry sand.

TABLE III.

	Moist sand.	Paraffin sand.	Totals.
Empty holes	3	18	21
Egg pods	15	0	15
Total diggings	18	18	36

In the third experiment tubes filled with moist sand were offered alongside tubes filled with dry sand impregnated with pure medicinal paraffin to a consistency closely resembling that of the moist sand. Table III shows that the same number of holes were dug in the two types of sand. Egg-pods were laid in over 80 per cent. of the holes made in the moist sand, but in none of those in paraffin-sand.

EFFECT OF AIR HUMIDITY ON PROBING.

Although the previous experiments showed that probing occurs in soft material, it was thought that it might also occur on a hard floor in a high air humidity. The observed rarity of probing on the hard floor of the breeding cages may have been due merely to one of the numerous sand tubes being quickly found and dug in. Two kinds of glass chamber were therefore prepared, both with perforated zinc false floors : one chamber had water beneath the false floor and a sealed-on glass lid to provide a high humidity, and the second had no water in it. Gravid females, seen actively working their ovipositor valves, but not yet probing, were taken from the breeding cage and observed in the different chambers. Not one of many such females was ever seen to probe in either of the chambers, although all continued sporadically working the valves with unbent abdomena. Females caught in the act of probing in one of the sand tubes, however, when transferred to the experimental chambers, continued active probing there. It made no difference to them which kind of chamber they were put in—vigorous probing continued against the metal floor for many minutes.

DISCUSSION.

The experiments throw light on three stages in the oviposition process :

(1) Probing—that is working of the ovipositor against the substrate with the abdomen bent at right angles but not yet extended.

(2) Digging—that is, continued working of the ovipositor valves while the abdomen extends and makes twisting movements.

(3) Oviposition proper—that is, extrusion of froth and eggs to form an egg pod as the abdomen is retracted out of the hole.

(1) *Probing* occurred indiscriminately in moist, dry, sodden and paraffin sand. In addition, short holes, and even an occasional defective egg-pod, have been found in moist cotton wool used to plug a hole in the metal floor of the breeding cage. Thus probing occurred in various soft materials regardless of their water-content or textural details.

High air humidity alone did not induce probing. Locusts were seen to probe only when in contact with sand or, on an entirely hard floor, only immediately after they had certainly been probing in sand, or probably had. In fact, there is no evidence of probing beginning except on a soft surface.

The *palpation* of the floor by the antennae and palps, carried out before probing in sand, suggests, without of course proving, that contact of those parts with a soft or loose-granular surface may be what usually sets off probing. Once probing has started on a soft surface, however, it persists energetically on a hard one. That is to say it may usually be released by certain external conditions but is not maintained or guided by them. Moreover, if the external conditions are lacking, probing might, nevertheless, eventually occur.

(2) *Digging* was less indiscriminate than probing, being restricted in dry or sodden sand as compared with moist sand. But it was normal in paraffin sand. Nikolsky (1925) observed that females cut short their digging and withdrew the abdomen, not only when they encountered a solid obstacle, but also when the sand was dry and the walls of the hole caved in. The caving-in of the walls of holes in sodden sand (Table II) and the running-down of dry sand from above (Table I), probably account for the restriction of digging and laying observed in the tubes concerned. Thus digging continued (until the abdomen was fully extended) as long as it produced an open, self-supporting burrow in which the abdomen could move freely.

It is noteworthy that two out of the three elements of digging, extension of the abdomen and twisting it, have not been seen except when the abdomen was in a hole in the ground. Unlike probing, digging either requires certain specific stimuli to keep it going or can be readily inhibited by stimuli other than the completion of the act itself.

Zakharov (1930, 1930*a*) found numerous empty pits dug by female *Locusta* on the oviposition sites. The empty pits were more frequent at the beginning of the oviposition period than later, which he regarded as evidence that the " digging instinct " developed before the females were ready for actual laying. Unfortunately it is not certain from his account that the condition of the soil did not improve (say become more moist) during that time. Boldyrev (quoted by Zakharov) suggested that empty pits were due to unsatisfactory soil conditions. The laboratory observations show that this is true at any rate of mechanical faults in the soil, but it is striking that 20–30 per cent. of the pits dug by females in the standard moist sand tubes in the present experiments were left empty while the rest, in identical sand, were filled with egg-pods. This could hardly be attributed to disturbance of the female by other locusts, for digging and ovipositing females were seen to be very resistant to such disturbance.

(3) *Oviposition* was prevented altogether in dry sand, and reduced in frequency in dry-topped moist sand and sodden sand. It was also interrupted and generally interfered with in sodden sand. All these effects can be attributed to the same circumstances that arrest digging: collapse of the burrow. On the other hand, no oviposition occurred in paraffin sand, in spite of successful digging. Failure to oviposit in paraffin sand may be merely due to some inhibitory effect of the paraffin. Alternatively, oviposition may require the presence of actual water-moisture in the hole. The extrusion of froth and eggs does occur sometimes outside a hole in the ground, with the abdomen straight and unextended, and the digging stage omitted. The pod is then not properly formed, and both eggs and froth dry up. Surface laying by *Locusta* has

occurred in my cages even when sand tubes were readily accessible and was observed in the field by Johnston and Maxwell-Darling (1931) when normal laying had apparently been prevented, despite much digging, by the dryness of the sand.

In addition to the three stages, probing, digging and oviposition, there is the preliminary descent to the ground mentioned by Fedorov (1927) and also the gaping movements of the ovipositor made with the abdomen unbent and unextended. The conditions under which these types of behaviour appear are not known. They may both be spontaneous, in the sense of requiring no specific external stimulus to elicit them once the insect has reached an appropriate internal condition. Further, it is not known what causal role copulation may play in releasing ovipository behaviour.

It is clear, however, that the whole ovipository sequence is neither rigidly determined from within nor dependent upon a definite sequence of external conditions. But the behaviour sequence that is successful (i.e. leaves the eggs with a good chance of hatching) occurs only when definite external conditions are supplied in a definite order, as they commonly are in nature. A tentative scheme of the normal, successful sequence of events is as follows:

high air humidity (or suitable food ?) ——→ sexual maturation and readiness to oviposit.
readiness to oviposit ——→ gaping and staying on the ground.
contact with soft ground ——→ probing.
probing + penetration ——→ digging.
digging + self-supporting hole ——→ completion of digging.
completion of digging (+ water in soil ?) ——→ oviposition.

SUMMARY.

1. Locusts lay their eggs in the ground at a depth up to several times the normal length of the abdomen, the holes being dug by the abdomen.

Laboratory experiments with *Locusta migratoria* showed that digging began just as much in dry sand as in moist or sodden, but was often abandoned in dry sand.

No egg pods were laid in dry sand, while a reduced number resulted when the sand was sodden.

2. When the sand was moistened with medicinal paraffin instead of water, full length digging occurred just as with sand wetted to the best consistency, but no eggs were laid.

3. Probing merely requires a soft surface; digging requires material in which a self-supporting burrow can be made, while oviposition may require water.

4. It therefore appears that in the field the initiation of digging requires soft soil, the completion of digging occurs most frequently when the soil is moist but not sodden, while the completion of the egg-laying process requires soil moistened with water.

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BOOK NOTICE.

Introduction to Applied Entomology. By William J. Baerg. 3rd edition. revised. 4to. Minneapolis (Burgess Publishing Co.), 1949. Pp. vii + 191, 208 figs. (Lithoprinted.) Price $3.50.

Arachnida as well as Insecta are included in the scope of this volume, and are dealt with first, after a brief introductory note on Arthropoda. Each family covered is discussed with its range, life-history, habits and poisonous properties. The most important species are mentioned, and half-tone figures given of many of them. For mites and ticks there are notes on injury to plants and animals, diseases transmitted, treatment, and control measures.

The section on Insecta begins with a general description of anatomy, internal and external, sense organs, reproduction and metamorphosis. The economic importance of insects is outlined, and the subject of insecticides dealt with in considerable detail. There is a section on biological control. The Orders of insects are treated successively, and in all but the smallest Orders the families of economic importance are treated individually. The general plan is the same as that for the Arachnida, but the treatment is more detailed.

For each family and other small sections one or two references are quoted, nearly always American sources. A short list of more general works is given near the beginning.

A STUDY OF *APHIS SAMBUCI* L. (HEMIPTERA: APHIDIDAE) AND A DISCUSSION OF ITS BEARING UPON THE STUDY OF THE "BLACK APHIDS."

Part I.

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Introduction.

Following the accidental discovery in September, 1944, of *Aphis sambuci* L. living on the roots of *Silene angustifolia* S. and T., and taking into consideration a number of interesting facts which were known about this species, it was thought that a detailed study of its morphology and biology might be of interest in relation to current work upon the *Aphis fabae* Scopoli complex. Jacob (1945) indicated how since about 1920, the "Black Aphids" have been split up according to such characters as hair length; the *A. sambuci* found on *S. angustifolia* was found in this and other characters to differ from specimens taken on the primary host, *Sambucus nigra* L., to a degree which might have been regarded by certain standards as specific in the *A. fabae* complex. The relationship of *A. sambuci* to the "Black Aphids" will be discussed in greater detail below; as, however, the morphology and biology of *A. sambuci* have not previously been described in any great detail, these aspects will be dealt with herewith.

A. sambuci has been referred to in all the main works published since Linnaeus's (1758) original description. Fabricius (1781, 1794) and Schrank (1801) both mention the species, but it was left to Kaltenbach (1843) to publish the first adequate description of the alate and apterous viviparous females. Mosley (1841) placed it in the genus *Cinara* Curtis. Amyot (1847) and Walker (1849*a*) are responsible for a number of synonyms; the former with *Sambucifex* and the latter with (?) *Aphis picta*, *Aphis exul* and (?) *Aphis advena*. Walker also describes the al. v. ♀ of *Aphis impacta* on *S. nigra*, but says that the antennae are longer than the body, and he had previously (1849) described this species on *Prunus spinosa*; the record on *S. nigra* was possibly casual and this species cannot be regarded as a synonym. *A. picta* is described from the apt. v. ♀, but the description reads like that of an old oviparous female of *A. sambuci*: it is regarded as a possible synonym. *A. exul* was regarded as a distinct species by Theobald (1927) but not by Hille Ris Lambers (1934); Walker's description leaves little doubt that it refers to the gynoparae and ovip. ♀ of *A. sambuci*. *A. advena* is possibly a male *A. sambuci* but this is questionable. Walker (1850 and 1870) described a number of varieties; these were the apparently normal variations which will be described below. Koch's (1854) description agrees with that of Kaltenbach in all essentials. Fitch (1855) mentions a species named *A. sambucifoliae* based, apparently, on a single alate male found on *S. nigra*; this is regarded as a synonym by Börner and Schilder (1932), but in a letter to the writer, Dr. Hille Ris Lambers says that he has reason to regard it as a distinct species. Passerini (1860)[1] described *A. sambucaria* from apterous and alate viviparous females. Buckton (1879) accepts this species and quotes Passerini's description of the apt. v. ♀; there is little doubt that it is really an ovip. ♀ of *A. sambuci*. Passerini's species was found in October and Buckton remarks that it is strange that *A. sambuci* is found on *S. nigra* in summer and *A. sambucaria* in winter. Van der Goot (1915) regards *A. sambucaria* as a synonym and describes the male and ovip. ♀ in addition to the apt. and al. v. ♀; Theobald (1927) however, regarded them as distinct.

Mordwilko (1907) made a considerable contribution to the biology of this species; he discovered *A. sambuci* on the roots of *Lychnis* spp. ("*L. pratense* and others") and succeeded in transferring it to *Lychnis* under laboratory conditions where, however, the aphids fed on the stems: this has been confirmed by the writer and will be referred to below. Although Mordwilko's paper is referred to by later writers (e.g. Van der Goot (1915) and Theobald (1927)) this important fact does not appear to have been noticed even by Börner (1931) who rightly suspected *A. sambuci* to be a migratory species. Laing (1923) described the apt. and al. v. ♀ of *A. wilsoni* from the roots of *Dianthus* spp. and Theobald (1927) quotes this description and describes males and ovip. ♀ from *Dianthus* and *Saxifraga* spp. However, Theobald's description of the ovip. ♀ is not convincing and his slides labelled as such, now in the British Museum (Natural History), do not contain ovip. ♀. This would suggest that Theobald mistook for ovip. ♀ the small apt. v. ♀ which occur on these hosts. For this and other reasons to be given below, the writer agrees with Hille Ris Lambers (1934) and Kloet and Hincks (1945) that *A. wilsoni* is a synonym of *A. sambuci*. Börner (1931) briefly summarized the life history as it was then known, and he succeeded in transferring *A. sambuci* to the leaves of *Rumex crispus* L. and *R. obtusifolius* L. Hille Ris Lambers (1934) states that he has only found it on the roots of *Rumex*; the writer has found that the transference to leaves of *Rumex* is easy, but that aphids are found on the aerial parts of *Rumex* only in situations where they could have fallen off *S. nigra* or alighted during flight; established colonies have only been found on subterranean parts. In a very brief description, Börner (1940) describes a short-haired new species on *S. nigra*, *Aphis sambucina* Börner; in the present investigation both long- and short-haired forms of *A. sambuci* have been found and the writer considers *A. sambucina* to be a further synonym.

In addition to Europe and North America, *A. sambuci* is also found in Japan, where both Matsumura (1917) and Takahashi (1923) have given accounts of it. Takahashi's description indicates that in Japan the biology of the aphid on *Sambucus* spp. is very similar to its biology in Great Britain, and he recognizes the sexual forms.

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[1] Hille Ris Lambers (1947) indicates the difficulty of obtaining the first edition (1857) of Passerini's *Gli Afidi*, but says that the second (1860) edition is not rare. The writer was unable to obtain in Great Britain a copy of either this paper or Passerini's (1863) *Aphididae Italicae*. A copy of the latter was eventually found in the Biblioteca Nazionale Vittorio Emanuel, Roma, where it is included in a bound collection of separates entitled *Miscellanea*. In this work Passerini appears to reproduce the earlier description of *A. sambucaria*.

Omitting the numerous references to *Aphis sambuci* by classical authors, the synonymy may therefore be summarized as follows :

A. sambuci Linnaeus, 1758.
Cinara sambuci Mosley, 1841.
Sambucifex Amyot, 1847.
? *A. picta* Walker, 1849.
A. exul Walker, 1849.
? *A. advena* Walker, 1849.
? *A. sambucifoliae* Fitch, 1855.
A. sambucaria Passerini, 1860.
A. wilsoni Laing, 1923.
A. sambucina Börner, 1940.

MORPHOLOGY OF *A. sambuci*.

During the course of this investigation a large amount of material was collected, and an additional large collection of experimental material has been accumulated. Examination of microscopical preparations has shown that there is a considerable amount of variation of taxonomic interest. It is proposed to describe these variations and to discuss briefly their taxonomic significance in relation to the study of the " Black Aphids." The varieties of apt. v. ♀ mentioned by Walker (1850), have been seen and appear to be normal ; and the measurements given by Van der Goot (1915) and Takahashi 1923) fall well within the range of variation observed in British specimens.

Fundatrix.

Not a single fundatrix has been found in nature, but several have been bred as the result of the crossing experiments to be described. Amongst this small collection there is appreciable variation in several characters.

Colour.—Dull green to very dark green with a slight coating of mealy wax. Antenna black with base of 3rd segment lighter. Head, siphunculi and cauda black. In the " brown " variety the orange larvae show through the cuticle.

Macerated specimen.—Similar to apt. v. ♀. Head, antennae, legs, siphunculi, cauda, anal and subgenital plates black ; otherwise only slight areas of pigmentation in front of the coxae and around the abdominal spiracles ; occasionally there are small pleural intersegmental scleroites. The marginal tubercles on the prothorax and 1st to 7th abdominal segments are large and rounded. The antennae are 5-jointed in all but one specimen, in which one is 5 and the other 6-jointed ; in this specimen the proportions (omitting joints I and II) are as follows :—Right, 14 : 4 : 7 : 6 + 9 ; left, 12 : 10 : 7 + 9 ; and a comparison with the other specimens suggests that the 4th segment of the right antenna is abnormally divided in this specimen. The antennae are about $\frac{1}{3}$–$\frac{1}{2}$ times as long as the body, III is $1\frac{1}{5}$–$2\frac{2}{3}$ times as long as IV ; the processus terminalis is 1–$1\frac{1}{2}$ times the base of V. The longest hairs on III are about $1\frac{2}{7}$–$1\frac{3}{8}$ times as long as the basal diameter of III. The siphunculi vary in size and shape but are generally short, thick at the base, strongly tapered and imbricated. The cauda is short, somewhat triangular with a strongly-rounded apex ; it is about $\frac{1}{2}$–$\frac{2}{3}$ times as long as the siphunculi. The last rostral segment is about $1\frac{1}{4}$–$1\frac{1}{3}$ times as long as the 2nd joint of the hind tarsus. The hind tibiae are approximately the same length as the antennae. There are 12–15 hairs on the cauda ; the anterior group of hairs on the subgenital plate consists of 4–11 and the posterior of 12–20 hairs.

As the dimensions of these fundatrices appear to bear some relation to their parentage, typical examples of each of the three groups into which they fall are given.

I. The result of mating in a clone of the " brown " variety (see below). Measurements of a single specimen :—Body : 2·22 mm. ; antenna : 0·97 mm. ; siphunculi : 0·37 mm. ; cauda : 0·20 mm. ; proportion of antennal segments : $\frac{100}{\text{III}}, \frac{43{\cdot}5}{\text{IV}}, \frac{35+35}{\text{V}}$.

II. The result of mating oviparous females of unknown origin with a single male from *Saxifraga* sp. :—Body : 2·63 mm. ; antenna : 0·87 mm. ; siphunculi : 0·28 mm. ; cauda : 0·20 mm. ; proportion of antennal segments : $\frac{100}{\text{III}}, \frac{55}{\text{IV}}, \frac{33+55}{\text{V}}$.

III. The results from a number of crosses including ♀♀ and ♂♂ from *Lychnis* and *Dianthus*, e.g. : *Lychnis* ♀♀ × *Dianthus* ♂♂, *Dianthus* ♀♀ × *Saxifraga* ♂, *Lychnis* ♀♀ × *S. nigra* clone ♂, and *S. nigra* clone ♀♀ × *Dianthus* ♂ :—Body : 2·18 mm. ; antenna : 0·80 mm. ; siphunculi : 0·33 mm. ; cauda : 0·15 mm. ; proportion of antennal segments : $\frac{100}{\text{III}}, \frac{83}{\text{IV}}, \frac{58+75}{\text{V}}$. It will be seen that the greatest variation is in the proportion of the antennal segments. In addition, the third segment is relatively long and thin in group I, and short and thick in group III.

Second Generation Apterous Viviparous Females.

The only known specimens available are the descendants of the above crosses. The only variation is one of colour. Morphologically these aphids are indistinguishable from wild apt. v. ♀♀ found on *S. nigra* in the spring, and any differences which do appear are not known to be independent of the unnatural environment in which the aphids were reared.

There are two colour forms :

(*a*) Body a dull brown colour with prominent transverse wax bars on the marginal and pleural areas of the abdomen.

(*b*) Similar to (*a*) but body is deep green to almost black.

The larvae of (*a*) are yellow to orange-brown in colour, of (*b*), light yellowish-green becoming greener with increasing age.

The brown form was obtained in all crosses except those in which a male from *Saxifraga* was used : the same male being responsible for each of three fertilizations.

Apterous Viviparous Female.

As already mentioned there are several varieties of the apt. v. ♀ : each will be described and their possible relationship discussed.

The first two varieties have been mentioned, and as apart from coloration they appear to be identical, they will be described as one and for purposes of comparison will be referred to as the typical form.

Living specimen.—Body dull brown or deep green to greenish-black. Prominent transverse intersegmental wax bars on the abdomen which may be reduced to small marginal bands : ventrally covered with an even coating of mealy wax. Head, antennae, pro- and mesothorax, siphunculi, cauda, legs, genital and anal plates, a transverse sclerite on the 8th abdominal segment and postsiphuncular sclerites all black.

Macerated specimen.—Head deeply pigmented, pro- and mesothoracic terga sclerotic and deeply pigmented, the latter with marked reticulations. Metathoracic and abdominal terga membranous with small postsiphuncular sclerites, small sclerites on 7th and 8th abdominal segments : abdominal stigmata are surrounded by small pigmented sclerotic areas, and there are somewhat diffuse intersegmental pleural sclerites on the abdomen. Antennae deeply pigmented, rather thick, clothed with long, outstanding hairs, III to VI imbricated : they are about $\frac{1}{2}$–$\frac{3}{4}$ times as long as the body ; III is about $1\frac{1}{3}$ times as long as IV ; IV about equal to or slightly longer or shorter than V ; processus terminalis is about equal to IV and is $1\frac{1}{3}$–2 times as long as the base of VI ; the longest hairs on III are 1–$1\frac{5}{13}$ times the basal diameter of III, but the diameter of this segment is variable. Rostrum reaches to or just beyond the second coxae, the last joint varies in shape but is 1–$1\frac{1}{10}$ times as long as the second joint of the hind tarsus. Siphunculi long, thick, tapering, imbricated, sclerotic and deeply pigmented, of very variable length equal to $2\frac{11}{16}$–$4\frac{1}{2}$ times as long as the cauda. Cauda short, rounded and deeply pigmented, with 13–20 hairs. There are large, clear, rounded marginal tubercles on the prothorax and abdominal segments 1–7. Apart from the very bases of the femora the legs are deeply pigmented. There are very few dorsal hairs. The hairs on the subgenital plate consist of an anterior group of 7–15 long hairs and a posterior group of 20–30. The above description applies to the spring form on *S. nigra.*

Measurements of a single specimen.—Body : 3·50 mm. ; antenna : 1·83 mm. ; siphunculi : 0·78 mm. ; cauda : 0·23 mm. ; proportion of antennal segments :

$$\frac{100}{\text{III}},\ \frac{71}{\text{IV}},\ \frac{64}{\text{V}},\ \frac{43+68}{\text{VI}}.$$

All other forms are characterized by the absence of the transverse wax bands on the abdomen, although marginal patches may occur. It will be sufficient to indicate how they differ from the above description. The morphology of the following forms appears to be correlated with their habitat, in that subterranean aphids tend to show a reduction in certain features such as pigmentation and size of appendages.

(a) *Root form on* S. nigra.

In life the body is dull olive green with a continuous coating of mealy wax. Head, prothorax, eyes, legs, siphunculi, cauda and irregular bars on abdominal segments 7 and 8, subgenital plate and antennae except for base of III black. Much smaller than the typical form.

The macerated specimen is much less deeply pigmented than the typical form, legs and rostrum are slender, the latter reaching beyond the 3rd coxae. The siphunculi are short, rather slender and tapering in specimens from some stations, thick at base and strongly tapering from others, about $1\frac{7}{10}$–$2\frac{3}{10}$ times as long as cauda. The last segment of the rostrum is about the same length as in the typical form, but from $1\frac{3}{7}$–$1\frac{2}{3}$ times as long as the 2nd joint of the hind tarsus. The longest hairs on the 3rd antennal segment may be equal to the basal diameter of the segment but are generally much shorter and the number of hairs on the subgenital plate is reduced.

(b) *Spring form of* (a).

In spring the root form feeds on the rapidly-growing basal shoots of the host. They give rise to apt. v. ♀♀ which aresimilar in size to the typical form ; they are dark to very dark green with a coating of mealy wax and, occasionally, marginal patches of wax. The pigmentation of the macerated specimen is not markedly different from the typical form ; the dimensions of the appendages are also similar ; such characters as the relative lengths of the antennal hairs to the base of III and the last segment of the rostrum to the 2nd joint of the hind tarsus are in close agreement.

TABLE I.—*Measurements of Single Apterous Viviparous Females of* A. sambuci *from Various Sources.*

Source of aphid.	Length of body (mm.).	Length of antenna (mm.).	Proportion of antennal segments.				Length of siphunculi. (mm.).	Length of cauda (mm.).	A.	B.	Hairs on subgenital plate.
			III.	IV.	V.	VI.					
(1) Roots of *S. nigra*	1·95	1·08	100	70	70	54+133	0·28	0·13	10 : 6	6 : 7	2+14
			13	*9*	*9*	*7+16*					
(2) Spring form of (1), on basal shoots	3·31	1·8	100	60	57	33+66	0·5	0·21	11 : 9	15 : 10	14+39
			30	*18*	*17*	*10+20*					
(3) Roots of *S. angustifolia*	2·36	1·4	100	72	72	42+116	0·46	0·18	11 : 7	4 : 7	3+12
			18	*13*	*13*	*75+21*					
(4) Roots of *L. alba*	1·95	1·23	100	62	68	43+124	0·38	0·15	10 : 7	4 : 8	2+13
			16	*10*	*11*	*7+20*					
(5) Roots of *L. dioica*	2·05	1·18	100	60	66	42+96	0·38	0·18	10 : 7	8 : 8	2+18
			17	*10*	*11*	*7+16*					
(6) Roots of *Dianthus* sp.	1·80	1·00	100	67	75	50+133	0·28	0·13	9 : 6	5 : 9	4+10
			12	*8*	*9*	*6+17*					
(7) Roots of *Saxifraga* sp.	1·43	0·76	100	75	75	63+175	0·23	0·10	8 : 5	3 : 6	2+11
			8	*6*	*6*	*5+14*					
(8) Roots of *Rumex* sp.	2·33	1·31	100	72	72	48+120	0·33	0·16	10 : 7	8 : 8	2+19
			17	*12*	*12*	*8+20*					

A.—Proportion of length of last segment of rostrum to the 2nd joint of the hind tarsus.
B.—Proportion of the longest hairs on antennal segment III to the basal diameter of the segment.
The figures in italics are the units in which the measurements were made : 1 unit = $\frac{1}{60}$ mm.

During the summer and when the colonies became crowded the typical form tends to lose its wax adornment; in culture the brown form lost wax and became dark green. In the autumn only green forms similar to (*b*) are found and they tend to become intermediate between (*a*) and (*b*) in some characters. During extremely adverse conditions the aphids become very small, lighter green and have a very pale almost colourless mid-dorsal patch.

(c) *Root forms on other hosts.*

These are very similar in appearance to (a). They are typical *A. sambuci* as far as the shape of the cauda and the marginal tubercles are concerned. The reduction in size, length of siphunculi and number and size of hairs on the antennae and subgenital plates are almost certainly induced by the habitat. The specimens from *Saxifraga* sp. are smaller than those from other hosts. In Table I, measurements of individual aphids from each host are recorded.

The Alate Viviparous Female.

As in the apt. v. ♀ it is necessary to describe one form fully and subsequently to refer to the variations. Colour variation occurs in the spring form derived from the "typical" apt. v. ♀, this form is arbitrarily regarded as the "typical" al. v. ♀. Somewhat inconstant morphological differences exist as between the "typical" al. v. ♀ and gynoparae, and between these forms and those derived from subterranean colonies; it is possible that some of these differences are simply individual variations as between one isolated colony and another.

Living specimen.—Head, antennae except for very base of III, thorax, siphunculi, cauda, anal and subgenital plates and legs except for bases of femora black. Abdomen and a band between pro- and mesothorax brown or dark green. Brown gynoparae have not been found and the subterranean forms are less heavily pigmented with a rather light green abdomen when fresh.

Macerated specimen.—Head, antennae except for very base of III, legs except for bases of femora, siphunculi, cauda, anal and subgenital plates, thorax except for a membranous band between pro- and mesothorax sclerotic and deeply pigmented. Abdomen membranous, clear except for large marginal sclerites on segments 2, 3 and 4, post- and antesiphuncular sclerites and small irregular transverse patches best developed on 6 and 7. There are small spiracular scleroites and well developed intersegmental scleroites. The antenna is about $\frac{2}{3}$ as long as the body; III is $1\frac{1}{5}$–$1\frac{2}{5}$ as long as IV and approximately equal to the processus terminalis; IV and V approximately equal, the processus terminalis is 2–$2\frac{1}{2}$ times as long as the base of VI; III bears about 17–30 rather large, round, secondary rhinaria, IV and V generally none. The antenna bears long outstanding hairs, the longest on III being $1\frac{1}{2}$–2 times as long as the basal diameter of III. The siphunculi are moderately long, imbricated and slightly tapered with a distinct flange; they are about 2–3 times as long as the cauda, which is short and tapering to a rounded apex and bears about 12–20 long hairs. The last segment of the rostrum is about $1\frac{1}{10}$–$1\frac{1}{5}$ times as long as the second joint of the hind tarsus. The subgenital plate bears 2–10 hairs in the anterior group and about 10–20 in the posterior group. There are large, rounded, marginal tubercles on the prothorax and abdominal segments 1–7.

Measurements of a single specimen.—Body: 2·53 mm.; antenna: 1·71 mm.; siphunculi: 0·41 mm.; cauda: 0·16 mm.; proportion of antennal segments:

$$\frac{100}{\text{III}}, \frac{64}{\text{IV}}, \frac{68}{\text{V}}, \frac{40+100}{\text{VI}}; \text{ secondary rhinaria: } \frac{28 \text{ and } 24}{\text{III}}, \frac{0 \text{ and } 0}{\text{IV}}, \frac{0 \text{ and } 0}{\text{V}}.$$

The above description is based on a single colony in North Wales; material from several other colonies has been found to agree with it, but variation is known to occur particularly in the number and size of the secondary rhinaria on III.

Variations.

(1) Al. v. ♀♀ derived from subterranean overwintering colonies on *S. nigra* differ conspicuously in two ways:

(*a*) Secondary rhinaria generally occur on segments IV and V; in the specimens available there are 4–13 on IV and 1–11 on V. (*b*) Corresponding to the apt. v. ♀, the antennal hairs are somewhat shorter than in the typical form; the longest hairs on III are from 1–1½ times as long as the basal diameter of III.

(2) Gynoparae. These are of two kinds; those which develop on *S. nigra* from mid-July onwards, and those which develop later in the season on the secondary host plants. The former differ from the typical form in having a few secondary rhinaria on IV and V, 0–11 and 0–4 respectively; secondly, there are not as a rule more than 1 or 3 hairs in the anterior group on the subgenital plate; the proportions of the antennal hairs are variable. The latter generally have more numerous and smaller secondary rhinaria, e.g. $\frac{30\text{–}40}{\text{III}}, \frac{10\text{–}20}{\text{IV}}, \frac{3\text{–}12}{\text{V}}$; they resemble closely the apt. v. ♀ from the same hosts in having relatively short antennal hairs and few hairs on the subgenital plate.

It is thought possible that the origin of gynoparae in a large random sample could be traced by means of the above differences; however, very much more extensive observations are required to settle this.

Nymphs of all forms have wax markings in the later instars.

The Apterous Oviparous Female.

Living specimen.—When young, bright yellow and oval in shape, older specimens become gradually darker, very old specimens being purplish brown.

Macerated specimen.—Body oval due to elongation of the posterior part of the abdomen, of variable size. Pigmentation is variable in intensity, it is confined to the head, sides of thorax and stigmal plates. Antennae rather thick, 6-jointed (sometimes imperfectly divided), with outstanding hairs, roughly $\frac{1}{3}$–$\frac{1}{2}$ times as long as the body; III is about equal in length to the processus terminalis, but may be only $\frac{2}{3}$ times as long; IV and V are approximately equal; the processus terminalis is 2–3 times as long as the base of VI. Siphunculi short, cylindrical, feebly imbricated, and flanged, they are only slightly longer than the cauda which is rounded. The subgenital plate is divided. Legs are rather thick; the hind tibiae being enlarged and bearing many pseudorhinaria along their whole length. There are large, rounded, marginal tubercles on the prothorax and abdominal segments 1–7.

Measurements of a single specimen.—Body: 1·80 mm.; antenna: 0·80 mm.; siphunculi: 0·12 mm.; cauda: 0·11 mm.; proportion of antennal segments:

$$\frac{100}{\text{III}}, \frac{60}{\text{IV}}, \frac{70}{\text{V}}, \frac{55 + 120}{\text{VI}}.$$

In culture in early December, 1946, intermediates were obtained which looked like the typical ovip. ♀ but contained both eggs and embryos; however, there is no evidence to show whether or not these forms can give birth to larvae.

The Alate Male.

Living specimen.—Very like the gynopara but smaller; abdomen becomes very dark in older specimens. Genitalia are black, siphunculi shorter and not deeply pigmented.

Macerated specimen.—Head and thorax moderately pigmented. Antennae strongly pigmented and imbricated, they are about $\frac{2}{3}$–$\frac{4}{5}$ the length of the body; the proportions of the segments are variable but in general similar to the al. v. ♀; III has 30–60, IV 13–30, and V 11–20 secondary rhinaria, and VI may have one or two. The antennal hairs seem to vary in length in the same way as in other stages, but none of the males available is definitely known to have originated in a natural healthy colony on *S. nigra*. The abdomen is membranous with small, pigmented marginal sclerites on segments 2, 3 and 4 and faint transverse bars may or may not be present on most segments; postsiphuncular sclerites may be present. Siphunculi are short, slender, cylindrical and imbricated; they are $1\frac{1}{2}$–$2\frac{1}{4}$ times as long as the cauda, which is short and rounded. Large, rounded marginal tubercles occur on the prothorax and abdominal segments 1–7. The last segment of the rostrum is about $1\frac{3}{10}$ times as long as the 2nd joint of the hind tarsus.

Measurements of a single specimen:—Body: 1·73 mm.; antenna: 1·36 mm.; siphunculi: 0·18 mm.; cauda: 0·11 mm.; proportions of antennal segments:

$$\frac{100}{\text{III}}, \frac{70}{\text{IV}}; \frac{60}{\text{V}} \quad \frac{40+100}{\text{VI}}; \text{ secondary rhinaria: } \frac{\text{35 and 41}}{\text{III}}, \frac{\text{23 and 28}}{\text{IV}}, \frac{\text{15 and 17}}{\text{V}}, \frac{\text{VI (base)}}{\text{2 and 0}}.$$

The egg.

When laid the eggs are pale yellowish-green, becoming shiny black within a few days.

(*To be continued.*)

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41, Queen's Gate, S.W. 7

1949

Wednesday, October 5
„ November 2
„ December 7

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